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Emplacement of energetic density currents over topographic barriers: constraints from a chemically-zoned, topography-draping, low aspect-ratio ignimbrite on Pantelleria, Italy.

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Low aspect-ratio ignimbrites are thought to be emplaced by particularly hazardous, radial, high-velocity pyroclastic density currents from caldera-forming eruptions. Their circular distribution has been inferred to record simultaneous flow in all directions from source, overtopping hills, rather than passively flowing down valleys.

As part of a study into how such currents behave and evolve with time, we have been testing the inference of simultaneous, radial (i.e. rather than sectoral) flow by mapping out the internal chemical-architecture of a zoned, low-aspect ratio ignimbrite sheet on the island of Pantelleria, Italy. This pristine, welded ignimbrite (aspect ratio $\leq$ 1:5,000) was deposited during a phase of the most recent ($\sim$45,000 ka) caldera-forming explosive eruption on the island. One extensive flow-unit is zoned from pantellerite to trachyte, and records that the composition of the erupting magma changed with time. Detailed logging with very close-spaced sampling for chemical and petrographic analysis has distinguished an internal chemical stratigraphy. The chemical variations allow us to divide the brief history of the sustained current into successive time-periods. The compositional zones have been mapped internally through the deposit, both (1) regionally (longitudinally from source and laterally around the broadly circular sheet), and (2) around topographic barriers draped by the ignimbrite. The study takes advantage of superlative exposure and topographic control. We have reconstructed how the footprint of the sustained current shifted as the current waxed then waned, and as it encountered and then overtopped barriers. Our data reveal that even this sheet-like low-aspect ratio ignimbrite was not emplaced entirely radially: rather, it flowed into certain sectors before others. Deposition was diachronous, and previously proposed lithofacies correlations within the ignimbrite are demonstrated to be incorrect.

We are now investigating how the current interacted with individual topographic barriers of different sizes and shapes. Both cone-shaped hills and transverse barriers, entirely draped by thin ignimbrite have been mapped in the field, and the chemical variations within the draping ignimbrite have been analysed up and around the topography. Data currently being processed should reveal whether the current's leading edge advanced over topographic barriers initially, as is commonly assumed, or that some barriers temporarily blocked or deflected the current until the mass-flux waxed (or until deposition modified the topography) sufficiently for the current to advance further. The well-constrained case studies will test the validity of concepts such as deflection and flow-stripping developed principally from analogue experiments.

Initial results are changing our understanding of how these unusually devastating pyroclastic density currents behave.